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ABSTRACT

Construction of an Automated Fiber Pigtailing Machine

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The goal of this ARPA-funded 2-year project is to design and build 3 low-cost machines to perform sub-micron alignments and attachments of single-mode fibers to different optoelectronic (OE) devices. This work is a collaboration among Uniphase Telecommunications Products (formerly United Technologies Photonics, UTP), Ortel, Newport/Klinger, the Massachusetts Institute of Technology Manufacturing Institute (MIT), and Lawrence Livermore National Laboratory (LLNL). UTP and Ortel are the industrial partners for whom two of the Automated Fiber Pigtailing Machines (AFPM) are being built. MIT and LLNL make up the design and assembly team of the project, while Newport/Klinger is a potential manufacturer of the AFPM and provides guidance to ensure that the design of the AFPM is marketable and compatible with a manufacturing environment. The AFPM for UTP will pigtail $LiNbO_3$ waveguide devices and the AFPM for Ortel will pigtail photodiodes. Both of these machines will contain proprietary information, so the third AFPM, to reside at LLNL, will pigtail a non-proprietary waveguide device for demonstrations to US industry.

The AFPM is designed to be low-cost (<$150K), modular, flexible, and compatible with a manufacturing environment. The AFPM will perform each pigtailing operation in less than 3 minutes (dominated by the epoxy curing time), and will incorporate a conveyor system to allow the machine to operate unattended for up to 1 hour. These machines use computer vision to align the fiber sufficiently close (few microns) to the OE device to couple light between the fiber and the device; the final sub-micron alignment is then achieved by maximizing the light throughput. The vision system greatly reduces mechanical fixturing constraints, can perform a limited amount of quality control, and increases flexibility by allowing different devices to be pigtailed with only software changes and minor mechanical changes. The modular nature of the AFPM means that each machine may be easily customized for a particular application. For this project, a basic set of modules was designed to build prototype AFPMs which can pigtail fibers to 3 very different geometries including a photodiode and two different types of waveguide devices; a different set of the same modules would allow laser diodes to be pigtailed, for example.

At this writing (October 1995), all prototype testing has been performed, design details have been finalized, and mechanical assembly of the machines has been completed. Software development and testing will progress through the fall of 1995. The schedule calls for the AFPMs to be delivered to the industrial partners near the end of CY1995. After incorporation of the machines into their manufacturing lines, the industrial partners will perform a short production run and evaluate the performance of the AFPMs. Modifications will then be suggested and will be incorporated into the final design of the AFPM where possible. At the end of the project in March 1996, LLNL will host the Final Design Review (FDR) to which representatives of US industry will be invited. At the FDR, all design details will made available and a pigtailing demonstration will be performed using the non-proprietary AFPM at LLNL. This paper will summarize the design of the AFPM and the results of the production demonstration.

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